Earth Polychromatic Imaging Camera (EPIC) Data Format Control Book Specification

Version 3

September 19, 2018

Goddard Space Flight Center
Greenbelt, Maryland

National Aeronautics and
Space Administration

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0   OVERVIEW

1.1   INTRODUCTION

This document is the Data Format Control Book (DFCB) for the Deep Space Climate Observatory (DSCOVR) Earth Polychromatic Imaging Camera (EPIC) instrument science data products. It describes the level 1A and 1B data products and defines their contents. All products are written in the standard Hierarchical Data Format 5 (HDF5) using HDF-defined data models and are archived at the Atmospheric Science Data Center (ASDC). Information about HDF5 and the official documentation and software may be found at the HDF web site: (http://www.hdfgroup.org/HDF5/)

1.2   PRODUCTS OVERVIEW

The EPIC instrument collects multispectral data of the Earth in ten wavelengths. The center wavelength of the bands are 317.5 nanometer (nm), 325nm, 340nm, 388nm, 443nm, 551nm, 680nm, 687.75nm, 764nm, and 779.5nm. Throughout this document, the wavelength of the 10 bands will be represented by three digital values rounded to the nearest integer.

There are two products produced. The first is the calibrated level 1A data in the original instrument orientation with geolocation appended. The second are the calibrated level 1B products that have all bands georectified to match the same grid with Earth oriented North up. From the DSCOVR spacecraft's unique vantage point near the Lagrange 1 (L1) point between the Earth and the Sun, the EPIC instrument collects data from nearly the entire sunlit surface of the Earth every hour. Unlike the products from other prior and current Earth science missions, the DSCOVR EPIC products contain data from sunrise to sunset of the Earth at a given moment in time. The Earth images will also contain an image of the Moon if it is within EPIC's field of view.
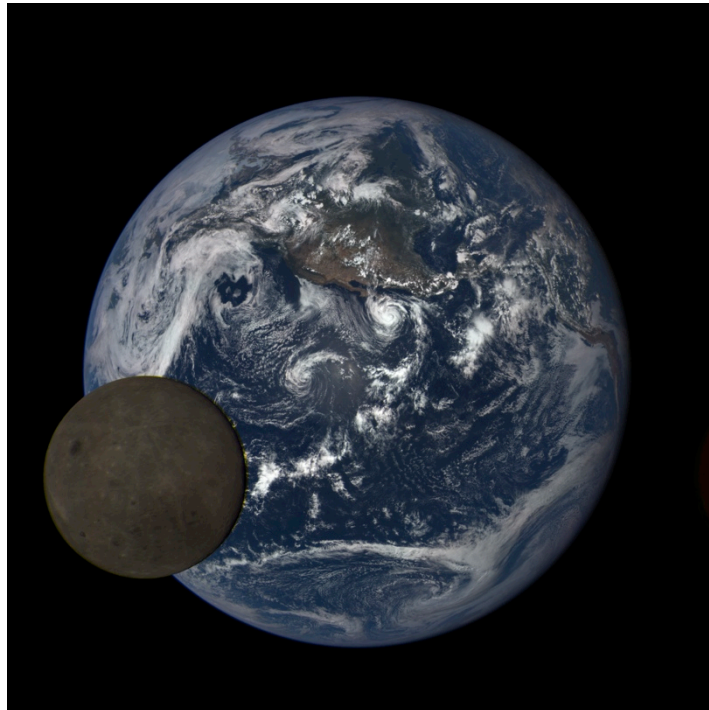
Figure 1-1. EPIC RGB image of Earth and Moon

Figure 1-1 is a view of the Earth-Moon system as it appeared to EPIC July 16th, 2015.

1.3   PURPOSE

This DFCB provides the user with a detailed description of the format and contents of the DSCOVR EPIC instrument data products. It contains descriptions of the image, location, and other ancillary data and their organization into HDF data objects. This document is the specification to which serves as a guide to the end users who will require data.

1.4   APPLICABLE DOCUMENTS

NASA, *Triana Scripps-EPIC Instrument Levels 1, 2, and 3 Science Data Products Data Format Control Book (DFCB)*

HDF Group, *Mapping HDF4 to HDF5 Objects, Version 3*
http://www.hdfgroup.org/HDF5/doc/ADGuide/H4toH5Mapping.pdf

HDF Group, *HDF5 Homepage*
http://www.hdfgroup.org/HDF5/

1.5   NAMING CONVENTION FOR THE HDF PRODUCT FILES

All of the data collected and processed for the EPIC instrument is written to two data files, a L1A and L1B HDF file. The following file naming conventions are followed when creating the product files. All time and coordinate values in the file names are those of the reference band. Each filename is thirty-six characters long and of the form "epic_ll_yyyymmddhhnn_vv.h5", for example "epic_1a_201504171840_ 01.h5"

Symbol	Meaning
ll	Indicated level of processing, either 1a or 1b
yyyy	four character year image was taken
mm	two character month images were taken
dd	two character day images were taken
hh	hour reference band was taken
nn	minute reference band was taken
vv	version number
h5	indicates file type is a HDF 5 file

2.0   LEVEL 1A PRODUCT

Each EPIC level 1A product consists of ten images corresponding to the ten different spectral wavelengths, or "bands", recorded approximately 30-60 seconds apart. The images are primarily of the full sun-lit Earth, with the exception of designated days instrument calibration activity will produce lunar and star field images instead of Earth images. Ancillary data associated with the band images includes geolocation data, Earth centroid coordinates, image collection times, and viewing geometry. Data is calibrated according to the L1A processing with its related sensor and optical corrections. The result is a single HDF5 file per image set, which is placed on the ASDC archive.

Data from all ten bands is collected at a regular cadence, resulting in 13 image-sets per day in the winter and 22 sets per day in the summer. Data will be downlinked from the spacecraft at either 2048 or 1024 resolution, depending on the product and the spacecraft mode, and compressed onboard using a custom 12-bit Joint Photographic Experts Group (JPEG) lossless or lossy codec. After ground processing, the image data in all the final level 1A products are compressed using the lossless gzip option provided by the HDF Application Programming Interface (API).

2.1   DATA VOLUMES

In nominal mode, each data product contains ten bands and their matching geolocation information. Bands can be missing due to spacecraft downlink issues or special imaging events. A complete level 1A product will be approximately 300 megabytes (MB). There is variance due to the size of the Earth in correlation with spacecraft distance.

Table 2-1. Data Volumes of Different Data Types Contained in the L1A Products

Object Description	Object Dimension	Size per object (MB)	Total number of Objects	Total size of all Objects	Compression ratio	Total size in file
Image data	2048x2048	16.77	10	167.77	2.8:1	59.92
Image Attributes	28	.163	280	1.6	Not applicable (N/A)	1.6
Geolocation data	2048x2048	16.77	20	335.54	3:1	111.84
Geolocation attributes	116	.8	1160	8	N/A	8
Root attributes	61	.460	61	.46	N/A	.46

2.2   HDF DIRECTORY STRUCTURE

In the layout for the HDF files, data is grouped by image bands. Within the band groups, the image data and its associated geolocation data is contained. Below is a snapshot using, the HDFView tool, representing the layout of an EPIC L1A product:
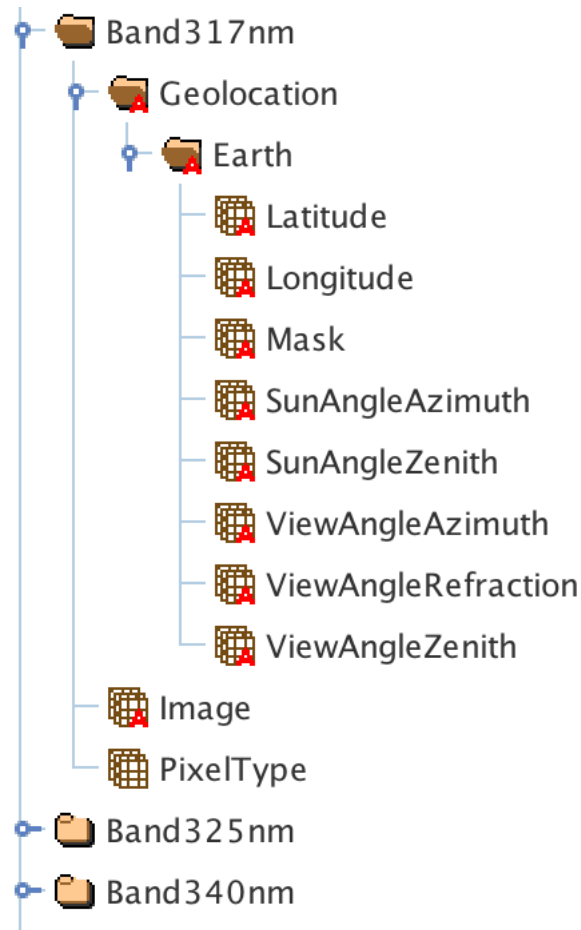
Figure 2-1. Image of the L1A HDF Group Directory Tree

/
The root group contains the band data sets and the subdirectories for geolocation information

/Band318nm
This group contains the image in the named band and geolocation grids.

/Band325nm
This group contains the image in the named band and geolocation grids.

/Band340nm
This group contains the image in the named band and geolocation grids.

/Band388nm
This group contains the image in the named band and geolocation grids.

/Band443nm
This group contains the image in the named band and geolocation grids.

/Band551nm
This group contains the image in the named band and geolocation grids.

/Band680nm
This group contains the image in the named band and geolocation grids.

/Band688nm
This group contains the image in the named band and geolocation grids.

/Band764nm
This group contains the image in the named band and geolocation grids.

/Band780nm
This group contains the image in the named band and geolocation grids.

2.3   ROOT ATTRIBUTES

Each root group directory contains a set of attributes that describes the contents of the HDF file. This includes the information about the bands present, the resolution they were taken, the resolution they were stored at, statistical information regarding data quality, and other sundries. Below is a list of the full metadata contents.

Table 2-2. L1A Root Attributes

Attribute Name	HDF Data Type	Units	Range	Description
band_317nm_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels
band_317nm_present	Uint8	Boolean	0..1	Indicates if band is present in dataset
band_317nm_resolution	Uint16	Pixels	0…2048	Indicates the resolution of the data in the dataset
band_317nm_resolution_native	Uint16	Pixels	0…2048	Indicates the resolution of the data as obtained from the spacecraft
band_325nm_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels
band_325nm_present	Uint8	Boolean	0..1	Indicates if band is present in dataset
band_325nm_resolution	Uint16	Pixels	0…2048	Indicates the resolution of the data in the dataset
band_325nm_resolution_native	Uint16	Pixels	0…2048	Indicates the resolution of the data as obtained from the spacecraft

Attribute Name	HDF Data Type	Units	Range	Description
band_317nm_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels
band_340nm_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels
band_340nm_present	Uint8	Boolean	0..1	Indicates if band is present in dataset
band_340nm_resolution	Uint16	Pixels	0…2048	Indicates the resolution of the data in the dataset
band_340nm_resolution_native	Uint16	Pixels	0…2048	Indicates the resolution of the data as obtained from the spacecraft
band_388nm_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels
band_388nm_present	Uint8	Boolean	0..1	Indicates if band is present in dataset
band_388nm_resolution	Uint16	Pixels	0…2048	Indicates the resolution of the data in the dataset
band_388nm_resolution_native	Uint16	Pixels	0…2048	Indicates the resolution of the data as obtained from the spacecraft
band_443nm_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels
band_443nm_present	Uint8	Boolean	0..1	Indicates if band is present in dataset
band_443nm_resolution	Uint16	Pixels	0…2048	Indicates the resolution of the data in the dataset
band_443nm_resolution_native	Uint16	Pixels	0…2048	Indicates the resolution of the data as obtained from the spacecraft
band_551nm_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels
band_551nm_present	Uint8	Boolean	0..1	Indicates if band is present in dataset
band_551nm_resolution	Uint16	Pixels	0…2048	Indicates the resolution of the data in the dataset
band_551nm_resolution_native	Uint16	Pixels	0…2048	Indicates the resolution of the data as obtained from the spacecraft
band_680m_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels

Attribute Name	HDF Data Type	Units	Range	Description
band_317nm_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels
band_680nm_present	Uint8	Boolean	0..1	Indicates if band is present in dataset
band_680nm_resolution	Uint16	Pixels	0…2048	Indicates the resolution of the data in the dataset
band_680nm_resolution_native	Uint16	Pixels	0…2048	Indicates the resolution of the data as obtained from the spacecraft
band_688nm_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels
band_688nm_present	Uint8	Boolean	0..1	Indicates if band is present in dataset
band_688nm_resolution	Uint16	Pixels	0…2048	Indicates the resolution of the data in the dataset
band_688nm_resolution_native	Uint16	Pixels	0…2048	Indicates the resolution of the data as obtained from the spacecraft
band_764nm_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels
band_764nm_present	Uint8	Boolean	0..1	Indicates if band is present in dataset
band_764nm_resolution	Uint16	Pixels	0…2048	Indicates the resolution of the data in the dataset
band_764nm_resolution_native	Uint16	Pixels	0…2048	Indicates the resolution of the data as obtained from the spacecraft
band_780nm_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels
band_780nm_present	Uint8	Boolean	0..1	Indicates if band is present in dataset
band_780nm_resolution	Uint16	Pixels	0…2048	Indicates the resolution of the data in the dataset
band_780nm_resolution_native	Uint16	Pixels	0…2048	Indicates the resolution of the data as obtained from the spacecraft
granule_version	String	N/A		Indicates version of calibration granule used

Attribute Name	HDF Data Type	Units	Range	Description
band_317nm_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels
begin_time	String			Beginning time of image set
calibration_file	String			Name of file with L1A calibrations settings used
centroid_mean_latitude	Float	Degrees	-90…90	Average centroid latitude across all the images
centroid_mean_longitude	Float	Degrees	-180…180	Average centroid longitude across all the images
date_created	String			Date dataset was processed and created
end_time	String			End time of image set
geolocation_algorithm	String			Revision of geolocation algorithm used in processing
geospatial_lat_max	Float	Degrees	-90…90	Maximum latitude value
geospatial_lat_min	Float	degrees	-90…90	Minimum latitude value
geospatial_lon_max	Float	Degrees	-180…180	Maximum longitude value
geospatial_lon_min	Float	Degrees	-180…180	Minimum longitude value
granule_version	String			Product version
institution	String			Creator of data
keywords	String			Keywords attached to data
maximum_latitude	Float	Degrees	-90…90	Maximum latitude value
minimum_latitude	Float	degrees	-90…90	Minimum latitude value
maximum_longitude	Float	Degrees	-180…180	Maximum longitude value
minimum_longitude	Float	Degrees	-180…180	Minimum longitude value
product_level	String		1B, 1A	Indicates produce level
project	String			Name of project

Attribute Name	HDF Data Type	Units	Range	Description
band_317nm_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels
image_set_date	String			Date and time images were taken
revision_number	String			Revision number of data set
calibration_file	String			Matching calibration data used to generate this dataset
summary	String			Description of dataset contents
title	String			Title of dataset

2.4   BAND GROUP

Each band directory group includes a grid with calibrated counts/second, and the geolocation grids for the Earth and Moon. Each image retains its natural orientation from when it was taken, and is not georeferenced to a common grid.

Table 2-3. L1A Band Group Data Contents

Name	Data type	Dimensions	Units	Description
Image	Float32	2048x2048 1024x1024	Counts/second	Image taken in units of calibrated counts/second
PixelType	Uint8	2048x2048	Symbols	Described pixel type and quality
/Geolocation/Earth	Group			Gridded Earth longitude and latitude values
/Geolocation/Lunar	Group			Gridded Lunar longitude and latitude values

2.4.1   PixelType Dataset

The PixelType dataset contains an array outputted by the L1A calibration process that describes the pixels in the dataset. This information includes whether the pixels are hot/cold, where they are located in the field of view (FOV), and other ancillary information in relation to calibration. The values of this dataset are keyed against the symbol table below.

Value	Symbol Name	Description
0	regular_on_target	Regular pixel on target, i.e. inside the FOV and illuminated by incoming light.

1	regular_off_target_1	Regular pixel with target influence, i.e. inside the FOV and nearby the illuminated region
2	regular_off_target_2	Regular pixel inside the FOV and not close to illumination
3	regular_off_target_3	Regular pixel around the edge of the FO and not close to illumination
4	regular_outside_FOV	Regular pixel outside the FOV and not close to illumination
10	oversampled_1	Fast (type 1) oversampled pixel not in edge column
11	oversampled_2	Slow (type 2) oversampled pixel
12	oversampled_double	Double oversampled pixel
13	edge_column_oversampled	Pixel in edge column of fast oversampled pixels
20	edge_column_1	Edge column pixel
21	edge_column_2	2nd edge column pixel
22	edge_row	Edge row pixel
25	regular_on_target_eff	Pixel has extreme flat field correction (>50%). Regular pixel on target, i.e. inside the FOV and illuminated by incoming light
26	regular_on_target_1_eff	Pixel has extreme flat field correction (>50%). Regular pixel with target influence, i.e. inside the FOV and nearby the illuminated region.
27	regular_off_target_2_eff	Pixel has extreme flat field correction (>50%). Regular pixel inside the FOV and not close to illumination.
28	regular_off_target_3_eff	Pixel has extreme flat field correction (>50%). Regular pixel around the edge of the FOV and not close to illumination.
29	regular_outside_FOV_eff	Pixel has extreme flat field correction (>50%). Regular pixel outside the FOV and not close to illumination.
35	oversampled_1_eff	Pixel has extreme flat field correction (>50%). Fast (type 1) oversampled pixel not in edge

		column.
36	oversampled_2_eff	Pixel has extreme flat field correction (>50%). Slow (type 2) oversampled pixel.
37	oversampled_double_eff	Pixel has extreme flat field correction (>50%). Double oversampled pixel.
38	edge_column_oversampled_eff	Pixel has extreme flat field correction (>50%). Pixel in edge column of fast oversampled pixels.
45	edge_column_1_eff	Pixel has extreme flat field correction (>50%). Edge column pixel.
46	edge_column_2_eff	Pixel has extreme flat field correction (>50%). 2nd edge column pixel.
47	edge_row_eff	Pixel has extreme flat field correction (>50%). Edge row pixel.
50	regular_on_target_mep	Pixel is moderately (type 1) enhanced pixel. Regular pixel on target, i.e. inside the FOV and illuminated by incomding light
51	regular_on_target_1_mep	Pixel is moderately (type 1) enhanced pixel. Regular pixel with target influence, i.e. inside the FOV and nearby the illuminated region.
52	regular_off_target_2_mep	Pixel is moderately (type 1) enhanced pixel. Regular pixel inside the FOV and not close to illumination.
53	regular_off_target_3_mep	Pixel is moderately (type 1) enhanced pixel. Regular pixel around the edge of the FOV and not close to illumination.
54	regular_outside_FOV_mep	Pixel is moderately (type 1) enhanced pixel. Regular pixel outside the FOV and not close to illumination.
60	oversampled_1_mep	Pixel is moderately (type 1) enhanced pixel. Fast (type 1) oversampled pixel not in edge column
61	oversampled_2_mep	Pixel is moderately (type 1) enhanced pixel. Slow (type 2) oversampled pixel
62	oversample_double_mep	Pixel is moderately (type 1) enhanced pixel.

		Double oversampled pixel
63	edge_column_oversampled_mep	Pixel is moderately (type 1) enhanced pixel. Pixel in edge column of fast sampled pixels.
70	edge_column_1_mep	Pixel is moderately (type 1) enhanced pixel. Edge column pixel
71	edge_column_2_mep	Pixel is moderately (type 1) enhanced pixel. 2nd edge column pixel.
72	edge_row_mep	Pixel is moderately (type 1) enhanced pixel. Edge row pixel.
75	regular_on_target_sep	Pixel is strongly (type 2) enhanced pixel. Regular pixel on target, i.e. inside the FOV and illuminated by incoming light.
76	regular_off_target_1_sep	Pixel is strongly (type 2) enhanced pixel. Regular pixel with target influence, i.e. inside the FOV and nearby the illuminated region.
77	regular_off_target_2_sep	Pixel is strongly (type 2) enhanced pixel. Regular pixel inside the FOV and not close to illumination.
78	regular_off_target_3_sep	Pixel is strongly (type 2) enhanced pixel. Regular pixel around the edge of the FO and not close to illumination.
79	regular_outside_FOV_sep	Pixel is strongly (type 2) enhanced pixel. Regular pixel outside the FOV and not close to illumination.
85	oversampled_1_sep	Pixel is strongly (type 2) enhanced pixel. Fast (type 1) oversampled pixel not in edge column.
86	oversampled_2_sep	Pixel is strongly (type 2) enhanced pixel. Slow (type 2) oversampled pixel.
87	oversampled_double_sep	Pixel is strongly (type 2) enhanced pixel. Double oversampled pixel.
88	edge_column_oversampled_xep	Pixel is strongly (type 2) enhanced pixel. Pixel in edge column of fast oversampled pixels.
95	edge_column_1_sep	Pixel is strongly (type 2) enhanced pixel. Edge Column pixel.

96	edge_column_2_sep	Pixel is strongly (type 2) enhanced pixel. 2nd edge column pixel.
97	edge_row_sep	Pixel is strongly (type 2) enhanced pixel. Edge row pixel.
150	regular_on_target_sat	Pixel is saturated. Regular pixel on target, i.e. inside the FOV and illuminated by incoming light
151	regular_off_target_1_sat	Pixel is saturated. Regular pixel with target influence, i.e. inside the FOV and nearby the illuminated region.
152	regular_off_target_2_sat	Pixel is saturated. Regular pixel inside the FOV and not close to illumination.
153	regular_off_target_3_sat	Pixel is saturated. Regular pixel around the edge of the FOV and not close to illumination.
154	regular_outside_FOV_sat	Pixel is saturated. Regular pixel around the FO and not close to illumination
160	oversampled_1_sat	Pixel is saturated. Fast (type 1) oversampled pixel not in edge column.
161	oversampled_2_sat	Pixel is saturated. Slow (type 2) oversampled pixel.
162	oversampled_double_sat	Pixel is saturated. Double oversampled pixel.
163	edge_column_oversampled_sat	Pixel is saturated. Pixel is edge column of fast oversampled pixels
170	edge_column_1_sat	Pixel is saturated. Edge column pixel.
171	edge_column_2_sat	Pixel is saturated. 2nd edge column pixel.
172	edge_row_sat	Pixel is saturated. Edge row pixel.
200	regular_on_target_bad	Pixel is bad. Regular pixel on target, i.e. inside the FOV and illuminated by incoming light.
201	regular_off_target_1_bad	Pixel is bad. Regular pixel with target influence, i.e. inside the FOV and nearby the illuminated region
202	regular_off_target_2_bad	Pixel is bad. Regular pixel inside the FOV and not close to illumination

203	regular_off_target_3_bad	Pixel is bad. Regular pixel around the edge of the FOV and not close to illumination
204	regular_outside_FOV_Bad	Pixel is bad. Regular pixel outside the FOV and not close to illumination
210	oversampled_1_bad	Pixel is bad. Fast (type 1) oversampled pixel not in edge column
211	oversampled_2_bad	Pixel is bad. Slow (type 2) oversampled pixel.
220	edge_column_1_bad	Pixel is bad. Edge column pixel.
221	edge_column_2_bad	Pixel is bad. 2nd edge column pixel.
222	edge_row_bad	Pixel is bad. Edge row pixel

2.4.2   Image Dataset Attributes

Each image defined above has attributes attached to it that describe the aspects of the data sets.

Table 2-4. L1A Image Attributes

Attribute Name	Data Type	Units	Range	Description
_FillValue	Float32	N/A	N/A	The value indicating no data or no valid data. This is set to "Infinity"
ccd_above_0_temperature	Float32	Celsius	> 0	Returns a valid temperature when CCD is above 0 Celsius
ccd_below_0_temperature	Float32	Celsius	< 0	Returns a valid temperature when CCD is below 0 Celsius (normal operating temperature)
ccd_read_mode	Uint16	N/A	51, 63	Indicates CCD read mode. Default is 51 (Mode 3).
centroid_center_latitude	Float32	degrees	-90…90	Center latitude value of object
centroid_center_longitude	Float32	degrees	-180..180	Center longitude value of object
exposure_actual	Float32	ms	N/A	Actual exposure of image as taken onboard
exposure_commanded	Float32	ms	N/A	Exposure commanded to EPIC computer
filter_wheel_1_location	uint8	N/A	1…6	Position of filter wheel 1
filter_wheel_2_location	uint8	N/A	1…6	Position of filter wheel 2
focus_location	uint8	N/A	N/A	Position of focusing mechanism
level_0_file	String	N/A	N/A	Name of level 0 data file processed
long_name	String	N/A	N/A	Descriptive name of dataset
maximum_value	Float32	counts/ second	N/A	Maximum pixel value in dataset excluding _FillValue pixels
mean_pixel_value	Float32	N/A	N/A	The mean pixel value in dataset excluding _FillValue pixels
minimum_value	Float32	N/A	N/A	The minimum pixel value in dataset excluding _FillValue pixels
percent_bad_pixels	Floats32	Percent	0…100	The percentage of pixels withing the image that are deemed bad. Marinagl other NULL pixels are excluded from computation
skewness	Float32	N/A	N/A	The skewness value computed from all pixels in the subject image exluding marginal fill and other NULL pixels
standard_deviation	Floats32	N/A	N/A	The standard deviation value computed from the set of all pixels in the subject image exluding marginal fill and other NULL pixels
time	String	N/A	N/A	Time (UTC) image taken in form "yyyy-mm-dd hh:mm:ss".
time_start_milliseconds	Uint16	seconds	N/A	Time imaging offset in milliseconds
time_start_seconds	Uint32	seconds	N/A	Time image taken in DSCOVR epoch format

units	String	N/A	N/A	The units of data.

2.4.3   Geolocation Attributes

The geolocation folder itself has attributes. This describes what was currently in view at the time EPIC was imaging

Table 2-5. Geolocation Folder Attributes

Attribute Name	Data Type	Units	Range	Description
field_of_view_darkspace	Uint8	N/A	0..1	Indicates if EPIC is viewing dark space
field_of_view_earth	Uint8	N/A	0..1	Indicates if EPIC is viewing Earth
field_of_view_lunar	Uint8	N/A	0..1	Indicates if EPIC is viewing Moon

If field_of_view_darkspace is 1, the field of view values for Earth and Moon is zero. If field_of_view_lunar is 1, the L1A contains no valid geolocation grids and no L1B is produced.

2.5   EARTH/LUNAR GROUP

These groups contain the respective Earth and Lunar latitude and longitude values, in grids corresponding to the EPIC image.

Table 2-6. L1A Earth/Lunar Geolocation Group Data Contents

Name	Data type	Dimensions	Units	Description
Latitude	Float32	2048x2048 1024x1024	degrees	Gridded Earth latitude values
Longitude	Float32	2048x2048 1024x1024	degrees	Gridded Earth longitude values
Mask	Uint8	2048x2048	Boolean	Contains zero and one values that indicate location of Earth pixels
SunAngleAzimuth	Float32	2048x2048	Degrees	Sun azimuth angles
SunAngleZenith	Float32	2048x2048	Degrees	Sun zenith angles
ViewAngleAzimuth	Float32	2048x2048	Degrees	Instrument azimuth viewing angles
ViewAngleRefreaction	Float32	2048x2048	Degrees	Expected distortion to zenith angle due to atmospheric refraction
ViewAngleZenith	Float32	2048x2048	Degrees	Instrument zenith viewing angles without refratction

2.5.1 Geolocation Earth Folder Attributes

Each geolocation Earth Folder defined above has attributes attached to it that describe the aspects of the data sets.

Table 2-7. Earth/Lunar geolocation group attributes

Attribute Name	HDF Data Type	Units	Description
apparent_sidereal_time	float32	degrees	Earth's apparent sidereal time
attitude_quaternion_0	float32	quaternion	Attitude quaternion 0 from star tracker
attitude_quaternion_1	float32	quaternion	Attitude quaternion 1 from star tracker
attitude_quaternion_2	float32	quaternion	Attitude quaternion 2 from star tracker
attitude_quaternion_3	float32	quaternion	Attitude quaternion 3 from star tracker
bottom_latitude	float32	degrees	Latitude value of pixel closest to bottom of the image
bottom_longitude	float32	degrees	Longitude value of pixel closes to bottom of the image
centroid_center_latitude	float32	degrees	Latitude at center of the Earth image
centroid_center_longitude	float32	degrees	Longtiude at center of the Earth image
centroid_equatorial_pixel_size	float32	pixels	Estimated Earth pixel size at equator
centroid_polar_pixel_size	float32	pixels	Estimated Earth pixel size at poles
centroid_x_pixel_offset	float32	pixels	X offset of center of Earth from center of the image
centroid_y_pixel_offset	float32	pixels	Y offset of center of Earth from center of the image
corrected_rotation_x	Float32	degrees	Corrected x rotation solution for transformation from ECR coordinates to spacecraft view.
corrected_rotation_y	Float32	degrees	Corrected y rotation solution for transformation from ECR coordinates to spacecraft view
corrected_rotation_z	Float32	degrees	Corrected z rotation solution for transformation from ECR coordinates to spacecraft view.
dscovr_declination	float32	degrees	DSCOVR's declination angle
dscovr_ephemris_x_position	float32	kilometers	DSCOVR X position in J2000 coordinates
dscovr_ephemris_x_velocity	float32	kilometers /second	DSCOVR X velocity
dscovr_ephemris_y_position	float32	kilometers	DSCOVR Y position in J2000 coordinates

Attribute Name	HDF Data Type	Units	Description
dscovr_ephemris_y_velocity	float32	kilometers /second	DSCOVR Y velocity
dscovr_ephemris_z_position	float32	kilometers	DSCOVR Z position in J2000 coordinates
dscovr_ephemris_z_velocity	float32	kilometers /second	DSCOVR Z velocity
dscovr_precession_ecliptic	float32	degrees	DSCOVR/Earth's precession in the ecliptic angle
dscovr_precession_equatorial	float32	degrees	DSCOVR/Earth's precession in the equatorial angle
dscovr_right_ascension	float32	degrees	DSCOVR's geocentric right ascension angle
earth_north_direction	float32	degrees	Rotation angle required to rotate image so North is oriented to the top of the image
east_longitude	float32	degrees	East-most longitude value
ecliptic_obliquity	float32	degrees	Earth's obliquity in the ecliptic
image_band	float32	degrees	Image band number
left_latitude	float32	degrees	Latitude value of pixel closest to left of the image
right_latitude	float32	degrees	Latitude value of pixel closest to right of the image
lunar_ephemris_x_position	float32	kilometers	Moon X position in J2000 coordinates
lunar_ephemris_x_velocity	float32	kilometers /second	Moon X velocity
lunar_ephemris_y_position	float32	kilometers	Moon Y position in J2000 coordinates
lunar_ephemris_y_velocity	float32	kilometers /second	Moon Y velocity
lunar_ephemris_z_position	float32	kilometers	Moon Z position in J2000 coordinates
lunar_ephemris_z_velocity	float32	kilometers /second	Moon Z velocity
north_latitude	float32	degrees	Northern-most latitude value
nutation_longitude	float32	degrees	Earth's nutation in longitude
nutation_obliquity	float32	degrees	Earths' nutation in obliquity
solar_apparent_declination	float32	degrees	Solar declination corrected for nutation and precession
solar_apparent_right_ascension	float32	degrees	Solar right ascension corrected for nutation and precession
solar_declination	float32	degrees	Sun's geocentric declination angle

Attribute Name	HDF Data Type	Units	Description
solar_ephemris_x_position	float32	kilometers	Sun X position in J2000 coordinates
solar_ephemris_x_velocity	float32	kilometers /second	Sun X velocity
solar_ephemris_y_position	float32	kilometers	Sun Y position in J2000 coordinates
solar_ephemris_y_velocity	float32	kilometers /second	Sun Y velocity
solar_ephemris_z_position	float32	kilometers	Sun Z position in J2000 coordinates
solar_ephemris_z_velocity	float32	kilometers /second	Sun Z velocity
solar_precession_ecliptic	float32	degrees	Sun/Earth's precession in the ecliptic angle
Solar_precession_equaotrial	Float32	degrees	Sun/Earth's precession in the equatorial angle
solar_right_ascension	float32	degrees	Sun's geocentric right ascension angle
south_latitude	float32	degrees	Southern-most latitude value
startracker_rotation_x	Float32	degrees	Original startracker x rotation solution for transformation from ECR coordinates to spacecraft view.
startracker_rotation_y	Float32	degrees	Original startracker y rotation solution for transformation from ECR coordinates to spacecraft view.
startracker_rotation_z	Float32	degrees	Original startracker z rotation solution for transformation from ECR coordinates to spacecraft view.
top_latitude	float32	degrees	Latitude value of pixel closest to top of the image
top_longitude	float32	degrees	Longitude value of pixel closest to top of the image
west_longtiude	float32	degrees	West-most longitude value

3.0   LEVEL 1B PRODUCT

The EPIC L1B contains the same 10 calibrated image bands as its corresponding L1A, however the products have been georectified to match a common grid. Ancillary data consists of image metadata, and the common grid. The format is mostly identical to the L1A. In L1B, because of the common grid, latitude and longitude are the same data set for each image and the values are shared by using an HDF5 link. Below is a snapshot representing the L1B product:
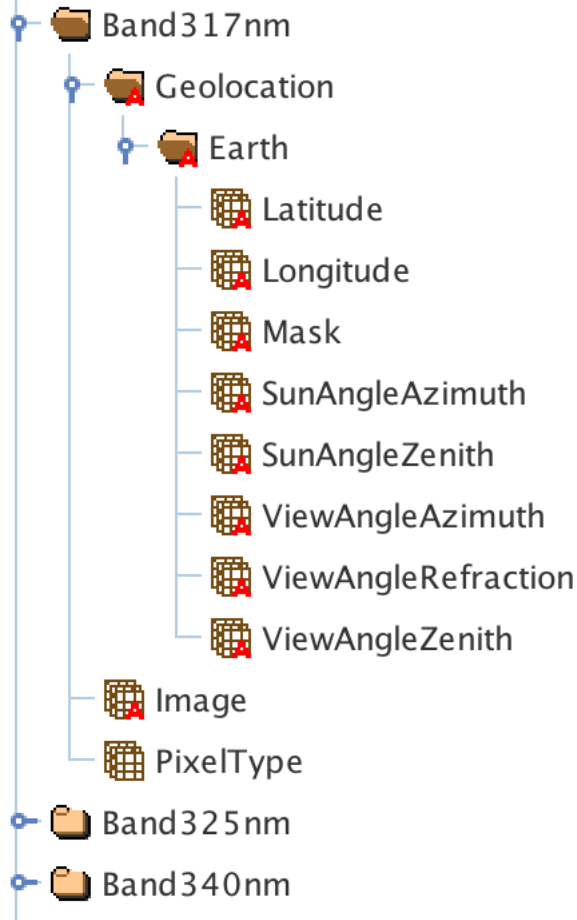
Figure 3-1. Image of the group directory structure for the L1B HDF product

3.1   GROUP STRUCTURE

The L1B root group directory contains the calibrated, georectified images produced, and has the relative geolocation information in subdirectories. The structure is as follows:

/
The root group contains the band data sets and the subdirectories for geolocation information

/Geolocation
This group contains the geolocation information for Earth and Lunar parts of the images.

/Geolocation/ Earth

This group contains the Earth latitude and longitude information, as well as solar and viewing angles.

/Geolocation/ Lunar
This group contains the Selenographic coordinates in terms of latitude and longitude

3.1.1 Calibrated, Geolocated Counts/second

These are the datasets containing the calibrated, geolocated counts/second per band.

Table 3-1. L1B Root Group Data Contents

Attribute Name	HDF Data Type	Units	Range	Description
band_317nm_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels
band_317nm_present	Uint8	Boolean	0..1	Indicates if band is present in dataset
band_317nm_resolution	Uint16	Pixels	0…2048	Indicates the resolution of the data in the dataset
band_317nm_resolution_native	Uint16	Pixels	0…2048	Indicates the resolution of the data as obtained from the spacecraft
band_325nm_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels
band_325nm_present	Uint8	Boolean	0..1	Indicates if band is present in dataset
band_325nm_resolution	Uint16	Pixels	0…2048	Indicates the resolution of the data in the dataset
band_325nm_resolution_native	Uint16	Pixels	0…2048	Indicates the resolution of the data as obtained from the spacecraft
band_340nm_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels
band_340nm_present	Uint8	Boolean	0..1	Indicates if band is present in dataset
band_340nm_resolution	Uint16	Pixels	0…2048	Indicates the resolution of the data in the dataset
band_340nm_resolution_native	Uint16	Pixels	0…2048	Indicates the resolution of the data as obtained from the spacecraft
band_388nm_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels

Attribute Name	HDF Data Type	Units	Range	Description
band_317nm_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels
band_388nm_present	Uint8	Boolean	0..1	Indicates if band is present in dataset
band_388nm_resolution	Uint16	Pixels	0…2048	Indicates the resolution of the data in the dataset
band_388nm_resolution_native	Uint16	Pixels	0…2048	Indicates the resolution of the data as obtained from the spacecraft
band_443nm_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels
band_443nm_present	Uint8	Boolean	0..1	Indicates if band is present in dataset
band_443nm_resolution	Uint16	Pixels	0…2048	Indicates the resolution of the data in the dataset
band_443nm_resolution_native	Uint16	Pixels	0…2048	Indicates the resolution of the data as obtained from the spacecraft
band_551nm_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels
band_551nm_present	Uint8	Boolean	0..1	Indicates if band is present in dataset
band_551nm_resolution	Uint16	Pixels	0…2048	Indicates the resolution of the data in the dataset
band_551nm_resolution_native	Uint16	Pixels	0…2048	Indicates the resolution of the data as obtained from the spacecraft
band_680m_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels
band_680nm_present	Uint8	Boolean	0..1	Indicates if band is present in dataset
band_680nm_resolution	Uint16	Pixels	0…2048	Indicates the resolution of the data in the dataset
band_680nm_resolution_native	Uint16	Pixels	0…2048	Indicates the resolution of the data as obtained from the spacecraft
band_688nm_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels
band_688nm_present	Uint8	Boolean	0..1	Indicates if band is present in dataset

Attribute Name	HDF Data Type	Units	Range	Description
band_317nm_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels
band_688nm_resolution	Uint16	Pixels	0…2048	Indicates the resolution of the data in the dataset
band_688nm_resolution_native	Uint16	Pixels	0…2048	Indicates the resolution of the data as obtained from the spacecraft
band_764nm_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels
band_764nm_present	Uint8	Boolean	0..1	Indicates if band is present in dataset
band_764nm_resolution	Uint16	Pixels	0…2048	Indicates the resolution of the data in the dataset
band_764nm_resolution_native	Uint16	Pixels	0…2048	Indicates the resolution of the data as obtained from the spacecraft
band_780nm_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels
band_780nm_present	Uint8	Boolean	0..1	Indicates if band is present in dataset
band_780nm_resolution	Uint16	Pixels	0…2048	Indicates the resolution of the data in the dataset
band_780nm_resolution_native	Uint16	Pixels	0…2048	Indicates the resolution of the data as obtained from the spacecraft
granule_version	String	N/A		Indicates version of calibration granule used
begin_time	String			Beginning time of image set
calibration_file	String			Name of file with L1A calibrations settings used
centroid_mean_latitude	Float	Degrees	-90…90	Average centroid latitude across all the images
centroid_mean_longitude	Float	Degrees	-180…180	Average centroid longitude across all the images
date_created	String			Date dataset was processed and created

3-4

Attribute Name	HDF Data Type	Units	Range	Description
band_317nm_percent_bad_pixels	Uint16	Percent	0..100	Indicates number of bad pixels
end_time	String			End time of image set
geolocation_algorithm	String			Revision of geolocation algorithm used in processing
geospatial_lat_max	Float	Degrees	-90…90	Maximum latitude value
geospatial_lat_min	Float	degrees	-90…90	Minimum latitude value
geospatial_lon_max	Float	Degrees	-180…180	Maximum longitude value
geospatial_lon_min	Float	Degrees	-180…180	Minimum longitude value
granule_version	String			Product version
institution	String			Creator of data
keywords	String			Keywords attached to data
maximum_latitude	Float	Degrees	-90…90	Maximum latitude value
minimum_latitude	Float	degrees	-90…90	Minimum latitude value
maximum_longitude	Float	Degrees	-180…180	Maximum longitude value
minimum_longitude	Float	Degrees	-180…180	Minimum longitude value
ppoduct_level	String		1B, 1A	Indicates produce level
project	String			Name of project
image_set_date	String			Date and time images were taken
revision_number	String			Revision number of data set
calibration_file	String			Matching calibration data used to generate this dataset
summary	String			Description of dataset contents
title	String			Title of dataset

3.1.2 Dataset Attributes

Each dataset defined above has attributes attached to it that describe the aspects of the data sets. This includes aspects of the image taking, geolocation, and data statistics.

Table 3-2. L1B Image Attributes

Attribute Name	Data Type	Units	Range	Description
_FillValue	Float32	N/A	N/A	The value indicating no data or no valid data. This is set to "Infinity"
ccd_above_0_temperature	Float32	Celsius	> 0	Returns a valid temperature when CCD is above 0 Celsius
ccd_below_0_temperature	Float32	Celsius	< 0	Returns a valid temperature when CCD is below 0 Celsius (normal operating temperature)
ccd_read_mode	Uint16	N/A	51, 63	Indicates CCD read mode. Default is 51 (Mode 3).
centroid_center_latitude	Float32	degrees	-90…90	Center latitude value of object
centroid_center_longitude	Float32	degrees	-180..180	Center longitude value of object
cordsys	String	N/A	N/A	Coordinate system
exposure_actual	Float32	ms	N/A	Actual exposure of image as taken onboard
exposure_commanded	Float32	ms	N/A	Exposure commanded to EPIC computer
filter_wheel_1_location	uint8	N/A	1…6	Position of filter wheel 1
filter_wheel_2_location	uint8	N/A	1…6	Position of filter wheel 2
focus_location	uint8	N/A	N/A	Position of focusing mechanism
level_0_file	String	N/A	N/A	Name of level 0 data file processed
long_name	String	N/A	N/A	Descriptive name of dataset
maximum_value	Float32	counts/second	N/A	Maximum pixel value in dataset excluding _FillValue pixels
mean_pixel_value	Float32	N/A	N/A	The mean pixel value in dataset excluding _FillValue pixels
minimum_value	Float32	N/A	N/A	The minimum pixel value in dataset excluding _FillValue pixels

Attribute Name	Data Type	Units	Range	Description
percent_bad_pixels	Floats32	Percent	0…100	The percentage of pixels withing the image that are deemed bad. Marinagl other NULL pixels are excluded from computation
skewness	Float32	N/A	N/A	The skewness value computed from all pixels in the subject image exluding marginal fill and other _FIllValue pixels
standard_deviation	Floats32	N/A	N/A	The standard deviation value computed from the set of all pixels in the subject image exluding marginal fill and other _FillValue pixels
time	String	N/A	N/A	Time (UTC) image taken in form "yyyy-mm-dd hh:mm:ss".
time_start_milliseconds	Uint16	seconds	N/A	Time imaging offset in milliseconds
time_start_seconds	Uint32	seconds	N/A	Time image taken in DSCVOR epoch format
units	String	N/A	N/A	The units of data.

3.1.3   **PixelType Dataset**

The PixelType dataset contains an array outputted by the L1A calibration process that describes the pixels in the dataset. This information includes whether the pixels are hot/cold, where they are located in the field of view (FOV), and other ancillary information in relation to calibration. The values of this dataset are keyed against the symbol table below. In the L1B, this data has been rotated from the original sensor formatted into the L1B grid. The data is in 8192x8192 pixel resolution, which is the format the data is in prior to remapping. To determine how this dataset and pixels map into the 2048x2048 L1B image, refer to the section on "Area Mapping" in "EPIC Geolocation and Color Imagery" document available via the Atmospheric Science Data Center.

Value	Symbol Name	Description
0	regular_on_target	Regular pixel on target, i.e. inside the FOV and illuminated by incoming light.
1	regular_off_target_1	Regular pixel with target influence, i.e. inside the FOV and nearby the illuminated region
2	regular_off_target_2	Regular pixel inside the FOV and not close to illumination

3	regular_off_target_3	Regular pixel around the edge of the FO and not close to illumination
4	regular_outside_FOV	Regular pixel outside the FOV and not close to illumination
10	oversampled_1	Fast (type 1) oversampled pixel not in edge column
11	oversampled_2	Slow (type 2) oversampled pixel
12	oversampled_double	Double oversampled pixel
13	edge_column_oversampled	Pixel in edge column of fast oversampled pixels
20	edge_column_1	Edge column pixel
21	edge_column_2	2nd edge column pixel
22	edge_row	Edge row pixel
25	regular_on_target_eff	Pixel has extreme flat field correction (>50%). Regular pixel on target, i.e. inside the FOV and illuminated by incoming light
26	regular_on_target_1_eff	Pixel has extreme flat field correction (>50%). Regular pixel with target influence, i.e. inside the FOV and nearby the illuminated region.
27	regular_off_target_2_eff	Pixel has extreme flat field correction (>50%). Regular pixel inside the FOV and not close to illumination.
28	regular_off_target_3_eff	Pixel has extreme flat field correction (>50%). Regular pixel around the edge of the FOV and not close to illumination.
29	regular_outside_FOV_eff	Pixel has extreme flat field correction (>50%). Regular pixel outside the FOV and not close to illumination.
35	oversampled_1_eff	Pixel has extreme flat field correction (>50%). Fast (type 1) oversampled pixel not in edge column.
36	oversampled_2_eff	Pixel has extreme flat field correction (>50%). Slow (type 2) oversampled pixel.
37	oversampled_double_eff	Pixel has extreme flat field correction (>50%).

		Double oversampled pixel.
38	edge_column_oversampled_eff	Pixel has extreme flat field correction (>50%). Pixel in edge column of fast oversampled pixels.
45	edge_column_1_eff	Pixel has extreme flat field correction (>50%). Edge column pixel.
46	edge_column_2_eff	Pixel has extreme flat field correction (>50%). 2nd edge column pixel.
47	edge_row_eff	Pixel has extreme flat field correction (>50%). Edge row pixel.
50	regular_on_target_mep	Pixel is moderately (type 1) enhanced pixel. Regular pixel on target, i.e. inside the FOV and illuminated by incomding light
51	regular_on_target_1_mep	Pixel is moderately (type 1) enhanced pixel. Regular pixel with target influence, i.e. inside the FOV and nearby the illuminated region.
52	regular_off_target_2_mep	Pixel is moderately (type 1) enhanced pixel. Regular pixel inside the FOV and not close to illumination.
53	regular_off_target_3_mep	Pixel is moderately (type 1) enhanced pixel. Regular pixel around the edge of the FOV and not close to illumination.
54	regular_outside_FOV_mep	Pixel is moderately (type 1) enhanced pixel. Regular pixel outside the FOV and not close to illumination.
60	oversampled_1_mep	Pixel is moderately (type 1) enhanced pixel. Fast (type 1) oversampled pixel not in edge column
61	oversampled_2_mep	Pixel is moderately (type 1) enhanced pixel. Slow (type 2) oversampled pixel
62	oversample_double_mep	Pixel is moderately (type 1) enhanced pixel. Double oversampled pixel
63	edge_column_oversampled_mep	Pixel is moderately (type 1) enhanced pixel. Pixel in edge column of fast sampled pixels.
70	edge_column_1_mep	Pixel is moderately (type 1) enhanced pixel.

3-9

		Edge column pixel
71	edge_column_2_mep	Pixel is moderately (type 1) enhanced pixel. 2nd edge column pixel.
72	edge_row_mep	Pixel is moderately (type 1) enhanced pixel. Edge row pixel.
75	regular_on_target_sep	Pixel is strongly (type 2) enhanced pixel. Regular pixel on target, i.e. inside the FOV and illuminated by incoming light.
76	regular_off_target_1_sep	Pixel is strongly (type 2) enhanced pixel. Regular pixel with target influence, i.e. inside the FOV and nearby the illuminated region.
77	regular_off_target_2_sep	Pixel is strongly (type 2) enhanced pixel. Regular pixel inside the FOV and not close to illumination.
78	regular_off_target_3_sep	Pixel is strongly (type 2) enhanced pixel. Regular pixel around the edge of the FO and not close to illumination.
79	regular_outside_FOV_sep	Pixel is strongly (type 2) enhanced pixel. Regular pixel outside the FOV and not close to illumination.
85	oversampled_1_sep	Pixel is strongly (type 2) enhanced pixel. Fast (type 1) oversampled pixel not in edge column.
86	oversampled_2_sep	Pixel is strongly (type 2) enhanced pixel. Slow (type 2) oversampled pixel.
87	oversampled_double_sep	Pixel is strongly (type 2) enhanced pixel. Double oversampled pixel.
88	edge_column_oversampled_xep	Pixel is strongly (type 2) enhanced pixel. Pixel in edge column of fast oversampled pixels.
95	edge_column_1_sep	Pixel is strongly (type 2) enhanced pixel. Edge Column pixel.
96	edge_column_2_sep	Pixel is strongly (type 2) enhanced pixel. 2nd edge column pixel.
97	edge_row_sep	Pixel is strongly (type 2) enhanced pixel. Edge row pixel.

150	regular_on_target_sat	Pixel is saturated. Regular pixel on target, i.e. inside the FOV and illuminated by incoming light
151	regular_off_target_1_sat	Pixel is saturated. Regular pixel with target influence, i.e. inside the FOV and nearby the illuminated region.
152	regular_off_target_2_sat	Pixel is saturated. Regular pixel inside the FOV and not close to illumination.
153	regular_off_target_3_sat	Pixel is saturated. Regular pixel around the edge of the FOV and not close to illumination.
154	regular_outside_FOV_sat	Pixel is saturated. Regular pixel around the FO and not close to illumination
160	oversampled_1_sat	Pixel is saturated. Fast (type 1) oversampled pixel not in edge column.
161	oversampled_2_sat	Pixel is saturated. Slow (type 2) oversampled pixel.
162	oversampled_double_sat	Pixel is saturated. Double oversampled pixel.
163	edge_column_oversampled_sat	Pixel is saturated. Pixel is edge column of fast oversampled pixels
170	edge_column_1_sat	Pixel is saturated. Edge column pixel.
171	edge_column_2_sat	Pixel is saturated. 2nd edge column pixel.
172	edge_row_sat	Pixel is saturated. Edge row pixel.
200	regular_on_target_bad	Pixel is bad. Regular pixel on target, i.e. inside the FOV and illuminated by incoming light.
201	regular_off_target_1_bad	Pixel is bad. Regular pixel with target influence, i.e. inside the FOV and nearby the illuminated region
202	regular_off_target_2_bad	Pixel is bad. Regular pixel inside the FOV and not close to illumination
203	regular_off_target_3_bad	Pixel is bad. Regular pixel around the edge of the FOV and not close to illumination
204	regular_outside_FOV_Bad	Pixel is bad. Regular pixel outside the FOV and not close to illumination

210	oversampled_1_bad	Pixel is bad. Fast (type 1) oversampled pixel not in edge column
211	oversampled_2_bad	Pixel is bad. Slow (type 2) oversampled pixel.
220	edge_column_1_bad	Pixel is bad. Edge column pixel.
221	edge_column_2_bad	Pixel is bad. 2nd edge column pixel.
222	edge_row_bad	Pixel is bad. Edge row pixel

3.2   GEOLOCATION

Contains the geolocation information as gridded values of latitude, longitude, sun, and view angles. These datasets correspond on a pixel-by-pixel basis to the image data.

3.2.1   Earth Geolocation Group

These grids contain values pertaining to the geolocation and solar and spacecraft view angles.

Table 3-3. L1B Earth Geolocation Group Data Contents

Field Name	Data Type	Units	Range	Description
Latitude	Float32	Degrees	-90…90	Grid of degrees latitude
Longitude	Float32	Degrees	-180…180	Grid of degrees longitude
SunAngleAzimuth	Float32	Degrees	0…180	Grid of sun azimuth angles
SunAngleZenith	Float32	Degrees	-90…90	Grid of sun Zenith angles
ViewAngleAzimuth	Float32	Degrees	0…180	Grid of spacecraft azimuth view angles
ViewAngleRefraction	Float32	Degrees	0…180	Grid of atmospheric refraction angles
ViewAngleZenith	Float32	Degrees	-90…90	Grid of spacecraft zenith angles
Mask	Uint8	N/A	0, 1	Location of Earth pixels

3.2.1.1   L1B Geolocation Metadata

Attribute Name	HDF Data Type	Units	Description
apparent_sidereal_time	float32	degrees	Earth's apparent sidereal time
attitude_quaternion_0	float32	quaternion	Attitude quaternion 0 from star tracker
attitude_quaternion_1	float32	quaternion	Attitude quaternion 1 from star tracker
attitude_quaternion_2	float32	quaternion	Attitude quaternion 2 from star tracker
attitude_quaternion_3	float32	quaternion	Attitude quaternion 3 from star tracker
bottom_latitude	float32	degrees	Latitude value of pixel closest to bottom of the image
bottom_longitude	float32	degrees	Longitude value of pixel closes to bottom of the image
centroid_center_latitude	float32	degrees	Latitude at center of the Earth image
centroid_center_longitude	float32	degrees	Longtiude at center of the Earth image
centroid_equatorial_pixel_size	float32	pixels	Estimated Earth pixel size at equator
centroid_polar_pixel_size	float32	pixels	Estimated Earth pixel size at poles
centroid_x_pixel_offset	float32	pixels	X offset of center of Earth from center of the image

3-13

Attribute Name	HDF Data Type	Units	Description
centroid_y_pixel_offset	float32	pixels	Y offset of center of Earth from center of the image
corrected_rotation_x	Float32	degrees	Corrected x rotation solution for transformation from ECR coordinates to spacecraft view.
corrected_rotation_y	Float32	degrees	Corrected y rotation solution for transformation from ECR coordinates to spacecraft view
corrected_rotation_z	Float32	degrees	Corrected z rotation solution for transformation from ECR coordinates to spacecraft view.
dscovr_declination	float32	degrees	DSCOVR's declination angle
dscovr_ephemris_x_position	float32	kilometers	DSCOVR X position in J2000 coordinates
dscovr_ephemris_x_velocity	float32	kilometers /second	DSCOVR X velocity
dscovr_ephemris_y_position	float32	kilometers	DSCOVR Y position in J2000 coordinates
dscovr_ephemris_y_velocity	float32	kilometers /second	DSCOVR Y velocity
dscovr_ephemris_z_position	float32	kilometers	DSCOVR Z position in J2000 coordinates
dscovr_ephemris_z_velocity	float32	kilometers /second	DSCOVR Z velocity
dscovr_precession_ecliptic	float32	degrees	DSCOVR/Earth's precession in the ecliptic angle
dscovr_precession_equatorial	float32	degrees	DSCOVR/Earth's precession in the equatorial angle
dscovr_right_ascension	float32	degrees	DSCOVR's geocentric right ascension angle
earth_north_direction	float32	degrees	Rotation angle required to rotate image so North is oriented to the top of the image
east_longitude	float32	degrees	East-most longitude value
ecliptic_obliquity	float32	degrees	Earth's obliquity in the ecliptic
image_band	float32	degrees	Image band number
left_latitude	float32	degrees	Latitude value of pixel closest to left of the image
right_latitude	float32	degrees	Latitude value of pixel closest to right of the image
lunar_ephemris_x_position	float32	kilometers	Moon X position in J2000 coordinates
lunar_ephemris_x_velocity	float32	kilometers /second	Moon X velocity

Attribute Name	HDF Data Type	Units	Description
lunar_ephemris_y_position	float32	kilometers	Moon Y position in J2000 coordinates
lunar_ephemris_y_velocity	float32	kilometers /second	Moon Y velocity
lunar_ephemris_z_position	float32	kilometers	Moon Z position in J2000 coordinates
lunar_ephemris_z_velocity	float32	kilometers /second	Moon Z velocity
north_latitude	float32	degrees	Northern-most latitude value
nutation_longitude	float32	degrees	Earth's nutation in longitude
nutation_obliquity	float32	degrees	Earths' nutation in obliquity
solar_apparent_declination	float32	degrees	Solar declination corrected for nutation and precession
solar_apparent_right_ascension	float32	degrees	Solar right ascension corrected for nutation and precession
solar_declination	float32	degrees	Sun's geocentric declination angle
solar_ephemris_x_position	float32	kilometers	Sun X position in J2000 coordinates
solar_ephemris_x_velocity	float32	kilometers /second	Sun X velocity
solar_ephemris_y_position	float32	kilometers	Sun Y position in J2000 coordinates
solar_ephemris_y_velocity	float32	kilometers /second	Sun Y velocity
solar_ephemris_z_position	float32	kilometers	Sun Z position in J2000 coordinates
solar_ephemris_z_velocity	float32	kilometers /second	Sun Z velocity
solar_precession_ecliptic	float32	degrees	Sun/Earth's precession in the ecliptic angle
Solar_precession_equaotrial	Float32	degrees	Sun/Earth's precession in the equatorial angle
solar_right_ascension	float32	degrees	Sun's geocentric right ascension angle
south_latitude	float32	degrees	Southern-most latitude value
startracker_rotation_x	Float32	degrees	Original startracker x rotation solution for transformation from ECR coordinates to spacecraft view.
startracker_rotation_y	Float32	degrees	Original startracker y rotation solution for transformation from ECR coordinates to spacecraft view.
startracker_rotation_z	Float32	degrees	Original startracker z rotation solution for transformation from ECR coordinates to spacecraft view.

Attribute Name	HDF Data Type	Units	Description
top_latitude	float32	degrees	Latitude value of pixel closest to top of the image
top_longitude	float32	degrees	Longitude value of pixel closest to top of the image
west_longtiude	float32	degrees	West-most longitude value

4.0   METADATA

Each file has a global attribute called "metadata" attached to it. This metadata is produced for searching purposes. This is an HDF attribute. The metadata attribute contains information about the product. It is a single character string with each *name=value* parameter pair delimited by a ";<LF>" character set. The <LF> character is defined as American Standard Code for Information Interchange (ASCII) code 0A in hex.

The values in the longitude and latitude fields are the geographic coordinates of the specified pixels in the Earth or Moon image. The centroids of the images are defined as the center of the Earth or Moon disk as it appears in the image. In the case of Moon images, the values are the lunar geographic (Selenographic) coordinates of the specified pixels in the Moon image. In the case of star field products, the *Centroid_latitude* and *Centroid_longitude* fields shall contain the approximate celestial coordinates (i.e., right-ascension and declination) of the centers of the fields of view. The *Lat* and *Lon* fields are not defined for star field products and shall contain null values.

The ten Band_xx_present parameters are always included in the metadata whether the band is present or not. The *Percent_bad_pixels_xx* fields are included in the metadata only for those bands actually contained in the product.

Table 4-1. L1B Metadata

Field Name	Data Type	Units	Range	Description
oroducer_granule_id	String	N/A	N/A	The name of the HDF file
granule_version	String		01…99	The processing version number of the products (2 digits with leading 0)
negin_time	String	N/A	N/A	Yyyy-mm-dd_hh:mm:ss date/time (UTC) of the first collected image
end_time	String	N/A	N/A	Yyyy0mmm-dd_hh:mm:ss date/time (UTC) of last collected image
centroid_latitude	String	Degrees	-90…90	Latitude of the image centroid for the referenced band
top_latitude	String	Degrees	-90…90	Latitude coordinate of the top-most point of the subject image based on the reference band
top_longitude	String	Degrees	-180…180	Longitude coordinate of the top-most point of the subject image based on the reference band
right_latitude	String	Degrees	-90…90	Latitude coordinate of the right most point of the subject image based on the reference band

Field Name	Data Type	Units	Range	Description
right_longitude	String	Degrees	-180…180	Longitude coordinate of the top-most point of the subject image based on the reference band
bottom_latitude	String	Degrees	-90…90	Latitude coordinate of the bottom-most point of the subject based on the reference band
left_latitude	String	Degrees	-90…90	Latitude coordinate of the left-most point of the subject image based on the reference band
left_longitude	String	Degrees	-180…180	Left longitude coordinate of the left-most point of the subject image based on the reference band
product_type	String	N/A	ON_HOUR, OFF_HOUR, MOON, STAR_FIELD, or SPECIAL	Indicates if the product is an on-hour or off-hour image of the Earth or an image of the Moon or space. Special products are any, which do not fit into the above categories
reference_band	String	N/A	01…10	Indicates the band used as the reference band.
browse_filename	String	N/A	N/A	The name of the associated external Browse file
comment	String	N/A	N/A	A miscellaneous text comment on the product. Default value is NULL
band_318nm_present	Char	N/A	Y or N	Indicates if band 1 is present in the product
band_325nm_present	Char	N/A	Y or N	Indicates if band 2 is present in the product
band_340nm_present	Char	N/A	Y or N	Indicates if band 3 is present in the product
band_388nm_present	Char	N/A	Y or N	Indicates if band 4 is present in the product
band_443nm_present	Char	N/A	Y or N	Indicates if band 5 is present in the product
band_551nm_present	Char	N/A	Y or N	Indicates if band 6 is present in the product
band_680nm_present	Char	N/A	Y or N	Indicates if band 7 is present in the product
band_688_present	Char	N/A	Y or N	Indicates if band 8 is present in the product
band_764_present	Char	N/A	Y or N	Indicates if band 9 is present in the product
band_780_present	Char	N/A	Y or N	Indicates if band 10 is present in the product

Field Name	Data Type	Units	Range	Description
percent_bad_pixels_318nm	String	Percent	0…9	Indicates the percentage of data pixels in the subject image in the given band, which failed quality checks. "NP" indicates band not present in product.
percent_bad_pixels_325nm	String	Percent	0…9	Indicates the percentage of data pixels in the subject image in the given band, which failed quality checks. "NP" indicates band not present in product.
percent_bad_pixels_340nm	String	Percent	0…9	Indicates the percentage of data pixels in the subject image in the given band, which failed quality checks. "NP" indicates band not present in product.
percent_bad_pixels_388nm	String	Percent	0…9	Indicates the percentage of data pixels in the subject image in the given band, which failed quality checks. "NP" indicates band not present in product.
percent_bad_pixels_443nm	String	Percent	0…9	Indicates the percentage of data pixels in the subject image in the given band, which failed quality checks. "NP" indicates band not present in product.
percent_bad_pixels_551nm	String	Percent	0…9	Indicates the percentage of data pixels in the subject image in the given band, which failed quality checks. "NP" indicates band not present in product.
percent_bad_pixels_680nm	String	Percent	0…9	Indicates the percentage of data pixels in the subject image in the given band, which failed quality checks. "NP" indicates band not present in product.
percent_bad_pixels_688nm	String	Percent	0…9	Indicates the percentage of data pixels in the subject image in the given band, which failed quality checks. "NP" indicates band not present in product.

Field Name	Data Type	Units	Range	Description
percent_bad_pixels_764nm	String	Percent	0…9	Indicates the percentage of data pixels in the subject image in the given band, which failed quality checks. "NP" indicates band not present in product.
percent_bad_pixels_780nm	String	Percent	0…9	Indicates the percentage of data pixels in the subject image in the given band, which failed quality checks. "NP" indicates band not present in product.
band_318nm_resolution	Uint16	Pixels	0…2048	Band resolution in pixels. Value is "0" if band not present.
band_325nm_resolution	Uint16	Pixels	0…2048	Band resolution in pixels. Value is "0" if band not present.
band_340nm_resolution	Uint16	Pixels	0…2048	Band resolution in pixels. Value is "0" if band not present.
band_388nm_resolution	Uint16	Pixels	0…2048	Band resolution in pixels. Value is "0" if band not present.
band_443nm_resolution	Uint16	Pixels	0…2048	Band resolution in pixels. Value is "0" if band not present.
band_551nm_resolution	Uint16	Pixels	0…2048	Band resolution in pixels. Value is "0" if band not present.
band_680nm_resolution	Uint16	Pixels	0…2048	Band resolution in pixels. Value is "0" if band not present.
band_688_resolution	Uint16	Pixels	0…2048	Band resolution in pixels. Value is "0" if band not present.
band_764_resolution	Uint16	Pixels	0…2048	Band resolution in pixels. Value is "0" if band not present.
band_780_resolution	Uint16	Pixels	0…2048	Band resolution in pixels. Value is "0" if band not present.
band_318nm_resolution_native	Uint16	Pixels	0…2048	Band resolution in pixels. Value is "0" if band not present.
band_325nm_resolution_native	Uint16	Pixels	0…2048	Band resolution in pixels. Value is "0" if band not present.

Field Name	Data Type	Units	Range	Description
band_340nm_resolution_native	Uint16	Pixels	0…2048	Band resolution in pixels. Value is "0" if band not present.
band_388nm_resolution_native	Uint16	Pixels	0…2048	Band resolution in pixels. Value is "0" if band not present.
band_443nm_resolution_native	Uint16	Pixels	0…2048	Band resolution in pixels. Value is "0" if band not present.
band_551nm_resolution_native	Uint16	Pixels	0…2048	Band resolution in pixels. Value is "0" if band not present.
band_680nm_resolution_native	Uint16	Pixels	0…2048	Band resolution in pixels. Value is "0" if band not present.
band_688_resolution_native	Uint16	Pixels	0…2048	Band resolution in pixels. Value is "0" if band not present.
band_764_resolution_native	Uint16	Pixels	0…2048	Band resolution in pixels. Value is "0" if band not present.
band_780_resolution_native	Uint16	Pixels	0…2048	Band resolution in pixels. Value is "0" if band not present.

4.1   L1B

4.2   L1A METADATA TEXT FORMAT

Band_551nm_present=1
Band_688nm_present=1
Band_680nm_present=1
Band_764nm_present=1
Band_780nm_present=1
Band_443nm_present=1
Band_388nm_present=1
Band_340nm_present=1
Band_325nm_present=1
Band_317nm_present=1
Percent_bad_pixels_551nm=0.00
Band_551nm_resolution=2048
Band_551nm_resolution_native=1024
Percent_bad_pixels_688nm=0.00
Band_688nm_resolution=2048
Band_688nm_resolution_native=1024
Percent_bad_pixels_680nm=0.00

Band_680nm_resolution=2048
Band_680nm_resolution_native=1024
Percent_bad_pixels_764nm=0.00
Band_764nm_resolution=2048
Band_764nm_resolution_native=1024
Percent_bad_pixels_780nm=0.00
Band_780nm_resolution=2048
Band_780nm_resolution_native=1024
Percent_bad_pixels_443nm=0.00
Band_443nm_resolution=2048
Band_443nm_resolution_native=2048
Percent_bad_pixels_388nm=0.00
Band_388nm_resolution=2048
Band_388nm_resolution_native=1024
Percent_bad_pixels_340nm=0.00
Band_340nm_resolution=2048
Band_340nm_resolution_native=1024
Percent_bad_pixels_325nm=0.00
Band_325nm_resolution=2048
Band_325nm_resolution_native=1024
Percent_bad_pixels_317nm=0.00
Band_317nm_resolution=2048
Band_317nm_resolution_native=1024
title=Deep Space Climate Observatory Earth Polychromatic Imaging Camera level 1A product
summary=This dataset contains an EPIC instrument image set. Images have been calibrated and geolocation information is appended.
keywords=DSCOVR, EPIC, imagery, L1A, lagrange, 551nm, 688nm, 680nm, 764nm, 780nm, 443nm, 388nm, 340nm, 325nm, 318nm
date_created=20-Aug-2014 11:17:44
institution=NASA/GSFC
project=Deep Space Climate Observatory
image_set_date=2013/01/01 00:06:36
revision_number=0.00
calibration_file=epiccal00.h5
Granule_version=01
begin_time=todo
end_time=todo
centroid_mean_latitude=-29.00
centroid_mean_longitude=-179.30
minimum_latitude=-90.00
maximum_latitude=61.07
minimum_longitude=-180.00
maximum_longitude=180.00
geospatial_lat_min=-90.00
geospatial_lat_max=180.00
geospatial_lon_min=-90.00

4.3   L1B SAMPLE METADATA (.MET)

Band_551nm_present=0/1
Band_688nm_present=0/1
Band_680nm_present=0/1
Band_764nm_present=0/1
Band_780nm_present=0/1
Band_443nm_present=0/1
Band_388nm_present=0/1
Band_340nm_present=0/1
Band_325nm_present=0/1
Band_317nm_present=0/1
Percent_bad_pixels_551nm=XXX.XX
Band_551nm_resolution=XXXX
Band_551nm_resolution_native=XXXX
Percent_bad_pixels_688nm=XXX.XX
Band_688nm_resolution=XXXX
Band_688nm_resolution_native=XXXX
Percent_bad_pixels_680nm=XXX.XX
Band_680nm_resolution=XXXX
Band_680nm_resolution_native=XXXX
Percent_bad_pixels_764nm=XXX.XX
Band_764nm_resolution=XXXX
Band_764nm_resolution_native=XXXX
Percent_bad_pixels_780nm=XXX.XX
Band_780nm_resolution=XXXX
Band_780nm_resolution_native=XXXX
Percent_bad_pixels_443nm=XXX.XX
Band_443nm_resolution=XXXX
Band_443nm_resolution_native=XXXX
Percent_bad_pixels_388nm=XXX.XX
Band_388nm_resolution=XXXX
Band_388nm_resolution_native=XXXX
Percent_bad_pixels_340nm=XXX.XX
Band_340nm_resolution=XXXX
Band_340nm_resolution_native=XXXX
Percent_bad_pixels_325nm=XXX.XX
Band_325nm_resolution=XXXX
Band_325nm_resolution_native=XXXX
Percent_bad_pixels_317nm=XXX.XX
Band_317nm_resolution=XXXX
Band_317nm_resolution_native=XXXX
title=<string>
summary=<string>
keywords=<string>
date_created=<string>
institution=<string>

project=<string>
image_set_date=<string>
revision_number=XXX
calibration_file=<string>
Granule_version=XX
begin_time=<string>
end_time=<string>
centroid_mean_latitude=XX.XX
centroid_mean_longitude=XXX.XX
minimum_latitude=XX.XX
maximum_latitude=XX.XX
minimum_longitude=XXX.XX
maximum_longitude=XXX.XX
geospatial_lat_min=XX.XX
geospatial_lat_max=XX.XX
geospatial_lon_min=XXX.XX

4.4   L1B METADATA TEXT FORMAT

Band_551nm_present=0/1
Band_688nm_present=0/1
Band_680nm_present=0/1
Band_764nm_present=0/1
Band_780nm_present=0/1
Band_443nm_present=0/1
Band_388nm_present=0/1
Band_340nm_present=0/1
Band_325nm_present=0/1
Band_317nm_present=0/1
Percent_bad_pixels_551nm=XXX.XX
Band_551nm_resolution=XXXX
Band_551nm_resolution_native=XXXX
Percent_bad_pixels_688nm=XXX.XX
Band_688nm_resolution=XXXX
Band_688nm_resolution_native=XXXX
Percent_bad_pixels_680nm=XXX.XX
Band_680nm_resolution=XXXX
Band_680nm_resolution_native=XXXX
Percent_bad_pixels_443nm=XXX.XX
Band_443nm_resolution=XXXX
Band_443nm_resolution_native=XXXX
Percent_bad_pixels_764nm=XXX.XX
Band_764nm_resolution=XXXX
Band_764nm_resolution_native=XXXX
Percent_bad_pixels_780nm=XXX.XX
Band_780nm_resolution=XXXX
Band_780nm_resolution_native=XXXX

Percent_bad_pixels_388nm=XXX.XX
Band_388nm_resolution=XXXX
Band_388nm_resolution_native=XXXX
Percent_bad_pixels_340nm=XXX.XX
Band_340nm_resolution=XXXX
Band_340nm_resolution_native=XXXX
Percent_bad_pixels_325nm=XXX.XX
Band_325nm_resolution=XXXX
Band_325nm_resolution_native=XXXX
Percent_bad_pixels_317nm=XXX.XX
Band_317nm_resolution=XXXX
Band_317nm_resolution_native=XXXX
title=<String>
summary=<String>
keywords=<String>
date_created=<String>
institution=<String>
project=<String>
image_set_date=<String>
revision_number=XXX.XX
calibration_file=<String>
Granule_version=XX
begin_time=<String>
end_time=<String>
centroid_latitude=XXX.XX
centroid_longitude=XXX.XX
minimum_latitude=XX.XX
maximum_latitude=XX.XX
minimum_longitude=XXX.XX
maximum_longitude=XXX.XX
geospatial_lat_min=XX.XX
geospatial_lat_max=XXX.XX
geospatial_lon_min=XXX.XX
Centroid_latitude=XX.XX
Centroid_longitude=XXX.XX
Top_latitude=XX.XX
Top_longitude=XXX.XX
Bottom_latitude=XX.XX
Bottom_longitude=XXX.XX
Left_latitude=XX.XX
Left_longitude=XXX.XX
Right_latitude=XXXXX
Right_longitude=XXX.XX

4.5 SAMPLE L1B METADATA (.MET) FILE

Band_551nm_present=1
Band_688nm_present=1
Band_680nm_present=1
Band_764nm_present=1
Band_780nm_present=1
Band_443nm_present=1
Band_388nm_present=1
Band_340nm_present=1
Band_325nm_present=1
Band_317nm_present=1
Percent_bad_pixels_551nm=0.00
Band_551nm_resolution=2048
Band_551nm_resolution_native=1024
Percent_bad_pixels_688nm=0.00
Band_688nm_resolution=2048
Band_688nm_resolution_native=1024
Percent_bad_pixels_680nm=0.00
Band_680nm_resolution=2048
Band_680nm_resolution_native=1024
Percent_bad_pixels_443nm=0.00
Band_443nm_resolution=2048
Band_443nm_resolution_native=2048
Percent_bad_pixels_764nm=0.00
Band_764nm_resolution=2048
Band_764nm_resolution_native=1024
Percent_bad_pixels_780nm=0.00
Band_780nm_resolution=2048
Band_780nm_resolution_native=1024
Percent_bad_pixels_388nm=0.00
Band_388nm_resolution=2048
Band_388nm_resolution_native=1024
Percent_bad_pixels_340nm=0.00
Band_340nm_resolution=2048
Band_340nm_resolution_native=1024
Percent_bad_pixels_325nm=0.00
Band_325nm_resolution=2048
Band_325nm_resolution_native=1024
Percent_bad_pixels_317nm=0.00
Band_317nm_resolution=2048
Band_317nm_resolution_native=1024
title=Deep Space Climate Observatory Earth Polychromatic Imaging Camera level 1B product
summary=This dataset contains an EPIC instrument image set. Images have been calibrated and geolocated.
keywords=DSCOVR, EPIC, imagery, L1B, lagrange, 551nm, 688nm, 680nm, 764nm, 780nm, 443nm, 388nm, 340nm, 325nm, 318nm

date_created=20-Aug-2014 10:09:03
institution=NASA/GSFC
project=Deep Space Climate Observatory
image_set_date=2013/01/01 00:06:36
revision_number=0.00
calibration_file=epiccal00.h5
Granule_version=01
begin_time=todo
end_time=todo
centroid_latitude=-29.00
centroid_longitude=-179.00
minimum_latitude=-90.00
maximum_latitude=61.07
minimum_longitude=-179.32
maximum_longitude=0.37
geospatial_lat_min=-90.00
geospatial_lat_max=87.37
geospatial_lon_min=-89.32
Centroid_latitude=-29.00
Centroid_longitude=-179.00
Top_latitude=0.00
Top_longitude=0.00
Bottom_latitude=0.00
Bottom_longitude=0.00
Left_latitude=0.00
Left_longitude=0.00
Right_latitude=0.00
Right_longitude=0.00

Appendix A. Abbreviations and Acronyms

Abbreviation/ Acronym	Definition
ASCII	American Standard Code for Information Interchange
API	Application Programming Interface
ASDC	Atmospheric Science Data Center
CCB	Configuration Control Board
CCD	Charge Coupled Device
CCR	Configuration Change Request
CFR	Code of Federal Regulations
CM	Configuration Management
CMO	Configuration Management Office
CSO	Chief Safety and Mission Assurance Officer
DFCB	Data Format Control Book
DSCOVR	Deep Space Climate Observatory
DSOC	DSCOVR Science Operations Center
ECR	Earth Centered Rotational
EPIC	Earth Polychromatic Imaging Camera
GS	Ground Segment
GSFC	Goddard Space Flight Center
GNU	GNU's Not Unix
GZIP	GNU zip
HDF	Hierarchical Data Format
ITAR	International Traffic in Arms Regulations
JPEG	Joint Photographic Experts Group
Km	Kilometer
Km/s	Kilometers per second
L1	Lagrange 1
L1A	Level 1 A
L1B	Level 1 B
Lat	Latitude
Lon	Longitude
LF	Line Feed
MB	Megabytes
ms	milliseconds
N/A	Not Applicable
NASA	National Aeronautics and Space Administration
nm	Nanometer
NP	Not Present
Rev	Revision
RGB	Red Green Blue
SPEC	Specification
U.S.	United States
UTC	Coordinated Universal Time